PROCEEDINGS

OF THE

ROYAL SOCIETY OF EDINBURGH.

1835. No. 6.

Monday, 2d February 1835.

SIR THOMAS MAKDOUGALL BRISBANE, K.C.B. President, in the Chair.

The following Donation was presented *:—

Transactions of the Royal Irish Academy. Vol. xvii. Part 1.—*By the Academy.*

The following Communication was read:—

On the History of the Arch. By Dr Traill.

Dr Traill stated, as the result of a careful examination of the passages in ancient authors, supposed to prove the early use of arches by the Greeks, that we must abandon all hope of solving this disputed point, by a reference to those authors; and he instanced the danger of inferences from such uncertain data, by comparing the description of the Treasury of Minyas, given by Pausanias, with the still remaining kindred edifice, the Treasury of the Atridæ at Mycenæ. He also noticed the loose sense in which the ancient Greeks employed the terms θολος, ψαλις, ἀψις.

* The Donations for the 19th January and 2d February have been inadvertently transposed.

He next examined the evidence of the ancient use of arches, derived from existing monuments. He shewed the existence of true arched conduits in two very ancient Grecian edifices, the ruins of the Temple of Apollo Didymæus, in the territory of Miletus, and that of Apollo Delphineus at Athens; but he pointed out reasons why the Greeks never used the arch as a conspicuous member of their architecture, though these examples shew that they were not ignorant of the principle of the arch.

In reviewing the specimens of early Italian art, he shewed that the arch was well understood by the ancient Etruscans. He contended, from ancient authorities, and the peculiarity of the masonry, that in the Emissary of the Alban Lake, the Cloaca Maxima at Rome, the substructions of the Temple of Tarpeian Jove, and probably also in the body of the Pantheon itself, we have genuine specimens of very ancient Etruscan art, in which arches form conspicuous members; and he shewed that, in the walls of Cortona, Fesulæ, and Volterra, in the ruins of the Theatre of Arezzo, in the Piscina of Volterra, and in the sepulchres of Perugia and Tarquinii, we have undoubted and very ancient specimens of Etruscan arches. In the temples of Egypt we have no examples of any arch, one of the arches figured in Belzoni's tenth plate being evidently Saracenic, and the others a mere hole, with a rounded top, cut in a wall; but the author exhibited specimens of both round and pointed arches, lately delineated by Mr George Hoskins junior, in the ancient royal tombs of Naputa and Meroe, which shew that arches were perfectly understood by the singular people of ancient Ethiopia.

The author next shewed that the pointed arch was long employed in eastern architecture before it was known in western Europe; a position which he illustrated by a collection of sketches from various authors.

He concluded this Essay by some observations on the extraordinary architecture of the ancient inhabitants of the table land of *Anahriac*, or Mexico, in which arches are distinctly visible; as may be seen in the designs of Dupaix, published in the magnificent work of Aglio; though the domes in the stupendous tombs of that people are constructed on the same principle as the Treasury of Atreus at Mycenæ.

Monday, 16th February.

DR HOPE, V. P. in the Chair.

The following Donations were presented:—

Records of General Science. By Robert D. Thomson, M. D. with the assistance of Thomas Thomson, M. D., F.R.S.L. and E. No. I. for January 1835.—*By the Author.*

Bulletin de la Société Géologique de France. Tome iv.—Feuilles 28–29.—*By the Society.*

Recherches sur l'Année Vague des Egyptiens. Par M. Biot.—*By the Author.*

Descriptive and Illustrative Catalogue of the Physiological Series of Comparative Anatomy contained in the Museum of the Royal College of Surgeons in London. Vol. ii.—*By the Royal College.*

On account of extraordinary business, no paper was read.

Monday, 2d March 1835.

SIR THOMAS M. BRISBANE, K. C. B., President, in the Chair.

The following Donations were presented:—

The Quarterly Journal of Agriculture: and the Prize Essays and Transactions of the Highland and Agricultural Society of Scotland, No. 28, for March 1835.—*By the Highland Society of Scotland.*

The American Almanac and Repository of Useful Knowledge for 1835. And

Transactions of the American Philosophical Society, held at Philadelphia, for promoting Useful Knowledge. Vol. v. Part 1. (New Series.)—*By the American Philosophical Society.*

Mécanique Céleste, by the Marquis de La Place, Peer of France, &c. Translated by Nathaniel Bowditch, LL.D. Vol. iii.—*By the Translator.*

Carte Physique de l'Isle de Teneriffe, levée sur les lieux, par Leopold de Buch, en 1814.—*By the Author.*

Carte des Côtes de France, sur laquelle on a indiqué la position et la nature des diverses especes de Feux établis ou a etablir sur ces côtes.—*By Mons. Fresnel.*

The following Communication was read:—

On the Anatomy of the Char. By Dr Knox.

This brief communication stated the results obtained from the examination of the state of the Char which are caught in the Lakes of Cumberland, particularly in relation to their food and habits of living. This subject the Author promised to resume in another paper.

Dr Gregory exhibited the apparatus by which Dobereiner effects the conversion of alcohol into acetic acid by the action of platinum.

Monday, 16*th March* 1835.

The Right Hon. LORD GREENOCK, Vice-President, in the Chair.

The following Donations were presented:—

Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce, for the Session 1833–34; being Part 1. of Vol. 50.—*By the Society.*

Bulletin de la Societé Géologique de France. Tome vi. Feuilles 1–4.—*By the Society.*

Correspondence Mathématique et Physique de l'Observatoire de Bruxelles, publiée par le Directeur A. Quetelet. Tome viii. Livraison 4.—*By the Author.*

Nouveaux Mémoires de l'Académie Royale des Sciences et Belles Lettres de Bruxelles. Tome viii.—*By the Society.*

Bulletin de l'Académie Royale des Sciences et Belles Lettres de Bruxelles, 1834. No. 25.—*By the Academy.*

Memorie della Reale Accademia della Scienze di Torino. Tome xxxvii.—*By the Academy.*

Description des Nouvelles Montres a Seconde, à l'usage des Ingénieurs, des Physiciens, des Médecins, &c. composés par Henri Robert.—*By the Author.*

Philosophical Transactions of the Royal Society of London, for the year 1834. Part 2.

Proceedings of the Royal Society. Nos. 17, 18.

List of the Fellows of the Royal Society, 1834–35.

Report on the Adjudication of the Copley, Rumford, and Royal Medals: and Appointment of the Bakerian, Croonian, and

Fairchild Lectures. By James Hudson, Assistant Secretary and Librarian.—*By the Royal Society.*

Astronomical Observations made at the Royal Observatory at Greenwich, in the months of April to September 1834. By John Pond, Esq., Astronomer Royal.—*By the Royal Society, London.*

The following Communications were read:—

1. The first part of a paper on the Ruins of Babylon. By Dr Traill.
2. On the application of the Hot Air Blast in the Manufacture of Cast-Iron. By Dr Clark, Aberdeen.

The author first gives a general account of the process of manufacture of cast-iron previous to the recent improvements, stating the quantities of the various materials put into the furnace, namely, of the Ore, the Fuel, and the Flux. He next states the method suggested first by Mr Neilson of Glasgow, and tried at the Clyde Iron-Works, for increasing the product of the furnaces with the same expense of materials, which consists in previously heating the air thrown into the furnace, in order to accelerate combustion. The method is found to produce a vast saving both in the fuel and the flux, although a certain portion of fuel has, of course, to be separately consumed for the purpose of heating the air, which is done by causing it to traverse a recurved pipe placed within a suitable furnace. During the first experiments, in 1830, the air was heated to 300° Fahrenheit. In 1831, Mr Dixon of the Calder Iron-Works thought of substituting raw coal for the coke which had hitherto been employed for fuel, at the same time that the air was still farther heated to 600° Fahrenheit, and with complete success. The result is, that *three times as much iron is now made by the use of a given weight of coal as formerly.* The following are the results of the experiments made at the Clyde Iron-Works.

In 1829, 111 tons of iron were produced from	403	of coke, or	888 of coal.
1830, 162	376	.	886
1831, 245		.	554

Dr Clark endeavours to point out the source of advantage thus obtained, from the enormous quantity of air which is thrown into a furnace in full action, which is not less than six tons weight in a minute, and which, therefore, must exercise the most important influence upon the mean temperature of the furnace.

Monday, 6th April.

SIR THOMAS M. BRISBANE, President, in the Chair.

The following Donations were presented:—

On the Vegetation and Temperature of the Faroe Islands. By W. C. Trevelyan, Esq.—*By the Author.*

Natuur en Scheikundig Archief, intgegeven door G. J. Mulder. 2 vols.

Leerboek voor Scheikundige Werktingkunde door G. J. Mulder. Vols. i. and ii. Part 1.—*By the Dutch Government.*

A List of Test Objects, principally Double Stars, arranged in Classes, for the trial of Telescopes in various respects as to Light, Distinctness, &c. By Sir J. F. W. Herschel.

A Second Series of Micrometrical Measures of Double Stars, chiefly performed with the seven feet Equatorial at Slough, in 1831, 1832, and 1833. By Sir J. F. W. Herschel.—*By the Author.*

On the Satellites of Uranus. By Sir J. F. W. Herschel.—*By the Author.*

In consequence of extraordinary business, no Communications were read.

Monday, 20th April.

SIR THOMAS M. BRISBANE, President, in the Chair.

The following Donations were presented:—

Voyage autour du Monde, entrepris par ordre du Roi, exécuté sur les Corvettes de S. M. l'Uranie et la Physicienne. Par M. Louis de Freycinet. 2 tomes 4to; and Atlas, folio.

Voyage autour du Monde, exécuté par ordre du Roi, sur la Corvette de Sa Majesté La Coquille. Par L. J. Duperrey. 1 Atlas, in folio.

Voyage de la Corvette L'Astrolabe, exécuté sous le Commandement de M. Jules Dumont D'Urville. 1 Atlas, in folio.

Voyage autour du Monde, exécuté sur la Corvette la Favorite, commandée par M. Laplace. 1 Atlas, in folio.

Le Pilote du Bresil, par le Baron Roussin. 1 vol. 8vo; and Atlas, in folio.

Description Nautique des Côtes de la Martinique. Par M. P. Monnier. 1 vol. 8vo; and Atlas, in folio.

Pilote de l'Ile de Corse. Par M. Hell. 1 Atlas, in folio.

Pilote Français. 3 Atlas, in folio.

Exposé des Travaux Rélatifs à la Reconnaisance Hydrographique des Côtes Occidentales de France. Par M. Beautemps-Beaupré. 4to.

Mémoires sur les Attérages des Côtes Occidentales de France. Par M. le Saulnier de Vanhello. 4to.

Collection de 66 Cartes et Plans *.

Table des Positions Géographiques. Par M. Daussy.—*By the Author.*

Catalogue des Préparations Anatomiques laissées dans la Cabinet d'Anatomie Comparée du Muséum d'Histoire Naturelle. Par G. Cuvier.—*By Madame Cuvier.*

Nouvelles Annales du Muséum d'Histoire Naturelle, 1834. Tome iii. Livraison 3.

The Journal of the Royal Asiatic Society of Great Britain and Ireland. No. 3.—*By the Society.*

Hints on the Trisection of an Angle, and Duplication of the Cube in Elementary Geometry. By Nasmyth Morrieson, W. S.—*By the Author.*

Chart of the Chinese Sea. By Captain Horsburgh, Hydrographer to the Hon. East India Company.—*By the Author.*

The following Communications were read :—

1. The conclusion of Dr Traill's paper on the Ruins of Babylon.

The author, after noticing the ancient writers who have left us any description of Babylon, mentioned the short accounts of *Benjamin of Tudela*, of *Rauwolf*, *Pietro della Valle*, *Pere Emmanuel*, *Niëbuhr*, and *Beauchamp*, from which little information is to be derived, compared to what may be gathered from a succession of British travellers ; among whom, first in point of time and importance, is Claudius James Rich, late British consul at Bagdad, whose steps have been successively followed by Kinneir, Ker Porter, Buckingham, Keppel, and Mignam.

He next gave a general description of the ruins, and a more detailed one of the *Kasr*, the *Mujellibah*, the *Embankment*, and the *Birs Nemroud*. The first he considered as the ruins of Nebuchadnezzar's palace ; the second as belonging to the palace, or to its

* All the above were presented by the French Government.

hanging gardens; the Embankments, with the hill of Amran, he believed to be a part of the defences of the city toward the river; and the Birs Nemroud, he considered with Rich as the ruins of the tower of Belus. He discussed at some length the arguments advanced by Rennell and Mignan against this latter opinion, chiefly founded on the account of Ctesias, that there were two palaces, one on each bank of the river, and that the principal one was on the *western* bank, and that the tower of Belus was on the opposite side. Ctesias being the only original writer who mentions two palaces, and his account not being confirmed by Herodotus, or any other ancient authority, and the glaring inconsistencies of his narrative in other respects entitling him to little credit, when he is not confirmed by other authors, it was concluded that we had no good reason to believe that two palaces had existed, far less that the most considerable was on the western bank of the river, especially as no remains, which can at all be regarded as the ruins of a palace, exist on that side; while in the Kasr we have remains of a pile, sumptuous in its material, of the finest furnace-baked brick, and magnificent for its extent, occupying a central position among the conspicuous ruins on the eastern bank, and enclosed on their sides by immense embankments, answering to the description left us by Herodotus of the strong interior wall which surrounded the palace.

The author next endeavoured to shew, that the Birs Nemroud answers better than any other of the remains to the description of the tower of Belus.

He next shewed, that the remains of reeds found between the courses of sun-dried bricks, correspond to Herodotus's description of reeds being used in the lower part of the Babylonian structures, —διὰ τριήκοντα δομῶν πλινθου—"for thirty courses of brick," not as our translators have made it, "*between every thirtieth course.*"

Lastly, he examined the varying accounts of ancient authors with regard to the extent of the walls of ancient Babylon, and shewed, that if we adopt the least circuit given to them, that of Ctesias and Diodorus Siculus, it would make the circuit of the city 41 miles, while that of Herodotus would give a circumference of 55 miles,— either of them vastly greater than any idea we can form by comparison with the largest of modern cities: but the author observed, that there is every reason to believe that the vast area was not filled with houses, but contained fields and orchards interspersed; which is not only probable from what we know of modern Asiatic

cities, but may be inferred from ancient authors, and especially from some remarks of Aristotle, who states that Babylon was rather "a community than a city" like the Pelopomesus. If we confine the city to the limits assigned by Diodorus, it will not include all the existing remains; whereas the limits assigned by Herodotus include all those venerable ruins in the vicinity of Hillah, that still astonish us by their stupendous dimensions.

2. On the Expansibility of different kinds of Stone. By Mr Alex. J. Adie, Civil Engineer.

This paper contains the results of an extensive series of experiments made upon different kinds of stone, as well as upon iron and upon brick, porcelain, and other artificial substances. The instrument employed was a pyrometer, of a simple construction, capable of determining quantities not greater than $\frac{1}{30,000}$ of an inch. The length of the substances generally employed was 23 inches. The general result of these experiments is, that the ordinary building materials of stone expand but very little differently from cast-iron, and that, consequently, the mixture of those materials in edifices is not injurious to their durability. The experiments from which the expansibility of the substances was numerically determined, were made between the limits of ordinary atmospheric temperature and that of 212°; steam being introduced for that purpose between the double casing of the instrument.

The following results were obtained for the fractional expansion of the length, for a change of temperature of 180° Fahr.:—

Table of the Expansion of Stone, &c.

	Decimal of length for 180° Fahr.
1. Roman Cement,	.0014349
2. Sicilian White Marble,	.00110411
3. Carrara Marble,	.0006539
4. Sandstone from the Liver Rock of Craigleith Quarry,	.0011743
5. Cast-iron from a rod cut from a bar cast 2 inches square,	.00114676
6. Cast-iron from a rod cast half an inch square,	.001102166
7. Slate from Penrhyn Quarry, Wales,	.0010376
8. Peterhead Red Granite,	.0008968
9. Arbroath Pavement,	.0008985
10. Caithness Pavement,	.0008947
11. Greenstone from Ratho,	.0008089
12. Aberdeen Gray Granite,	.00078943
13. Best Stock Brick,	.0005502
14. Fire Brick,	.0004928
15. Stalk of a Dutch Tobacco-pipe,	.0004573
16. Round rod of Wedgewood Ware (11 inches long),	.00045294
17. Black Marble from Galway, Ireland,	.00044519

Monday, 27th April.

SIR THOMAS M. BRISBANE, President, in the Chair.

The following Communications were read:—

1. On the Action of Voltaic Electricity on Alcohol, Ether, and Aqueous Solutions. By Arthur Connell, Esq.

The author was led into the following investigations, from observing that when alcohol, holding a minute quantity of pure caustic potash, as $\frac{1}{300}$ part, in solution, was acted on by a moderate voltaic power, as a small battery of fifty pairs of two-inch plates, evident marks of decomposition were exhibited, by an evolution of gas from the negative pole, and none from the positive. The experiment recalled to the author's recollection a statement made a few years ago by Dr Ritchie (Phil. Trans. 1832), that when alcohol not holding any substance in solution, was acted on by a powerful battery, gas was given off at the negative pole, which Dr Ritchie stated to be olefiant gas. The author therefore thought, that the elastic fluid evolved in his experiment might be olefiant gas; but on examining it by chlorine, and in the voltaic eudiometer, it proved to be hydrogen, mixed, when collected from alcohol in contact with atmospherical air, with a variable proportion of the constituents of atmospheric air, which had been dissolved by the liquid, but quite pure when the alcohol was exposed to the vacuum of an air-pump and then acted on in a close tube. The same result was obtained when alcohol of sp. gr. .7928 at 66° F. was employed as with alcohol of .830. When the experiment was made on alcohol containing $\frac{1}{200}$ of potash in a small tube, with poles of platinum-foil placed side by side at a short distance from one another, and seventy pairs of four-inch plates were used, the liquid became extremely hot, and even boiled, and became gradually reddish; and some carbonate of potash was precipitated; but it was only when the action was very energetic that the carbonic acid was formed. Small quantities of other soluble substances, such as chloride of calcium and boracic acid, produced the same effect as potash in causing an evolution of gas, but to a much less extent. It was then found that if alcohol, sp. gr. .7928, holding nothing in solution, was acted on by 216 pairs of four-inch plates in a small tube with platinum-foil poles, brought within $\frac{1}{20}$ or $\frac{1}{30}$ of an inch of one another, gas was evolved, as before, from the negative pole, and none from the positive; and the gas proved to be hydrogen, as before,

mixed with a small quantity of atmospheric air derived from the liquid. The alcohol, after the action, was found to contain a minute quantity of resinous matter.

The effect of the presence of minute quantities of foreign substances is to increase the conducting power, as is shewn by an increased action on the galvanometer. The alcohol is thus rendered more easily decomposable.

The action in these cases is conceived to consist in the voltaic decomposition of water contained in the alcohol, apparently as a constituent, when absolute alcohol is acted on; the hydrogen being evolved at the negative pole, and the oxygen being absorbed by the fluid, conformably to those instances of absorption of oxygen which are known to occur in the case of the acetous fermentation, in that of an alcoholic solution of potash exposed to the air, and in other instances. The formation of carbonic acid during the voltaic action corresponds to that of acetic and formic acids in the other instances alluded to, but shews a more powerful oxidation.

The positive gas could, in certain circumstances, be made to appear in addition to the negative, as, by diluting the alcohol with an equal bulk of water, or by dissolving $\frac{1}{100}$ of potash in alcohol of sp. gr. .840; and also by arrangements producing certain electrical effects, as by reversing the battery after it had been some time in action, and also by performing the experiment in metal vessels instead of those of glass or porcelain.

When alcohol, sp. gr. .796, holding a minute quantity of potash dissolved, was compared with water holding the same quantity of potash in solution, by passing the same current of electricity through both solutions, in the arrangement called by Mr Faraday the Volta-electrometer, it was found that the same quantity of gas was evolved from both negative poles, showing that in both solutions water was the subject of decomposition. The conclusion from the whole is, that water, as such, enters into the constitution of alcohol.

Pure ether, rectified over chloride of calcium, was exposed to the action of 216 pairs of 4-inch plates, without the slightest symptom of decomposition, or action on a galvanometer, consisting of a single magnetic needle 7 inches long, in the centre of 30 circuits of insulated copper-wire. Neither was it decomposed when it held corrosive sublimate, chloride of platinum, or chromic acid, in solution. The author therefore concludes, that ether does not contain water as a constituent.

Assuming it to be proved that alcohol is a hydrate, the author